Digital Product Passport (DPP) and the adoption of GS1 standards for the identification of construction products

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Abstract

Under the framework of the EU Green Deal, setting the objective of becoming the first climate-neutral region by 2050, the European Union (EU) adopted the Construction Products Regulation (CPR) proposal on 30th March 2022. The proposed regulation includes the EU Digital Product Passport (DPP), a new concept. In addition, the proposed regulation sets mandatory green public procurement criteria. The overall aim of the proposal is to reduce the life cycle environmental impact of products through efficient digital solutions and also to enable the objectives of EU industrial policy such as boosting the demand for sustainable goods and supporting sustainable production.

From 2026 on, companies will be obliged to identify their products and supply chain events in order to be compliant with the new requirements. But how can CO2 emissions be calculated, and supply chain events regarding finished products be recorded and disclosed, if products are not correctly identified?

The aim of this paper is to investigate how GS1 standards can be applied to construction products in order to meet the DPP requirements for globally unique, interoperable and non-proprietary methods of product identification. As the DPP for construction products is a new concept, the methodology of research for this paper is the problem-solving approach (action research) based on a desk study. It analyses the requirements of the DPP and investigates how GS1 Standards can address them.

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1. Introduction

GS1 is a neutral, not-for-profit, global collaborative standards organisation that brings together industry leaders, government, regulators, academia, and industry associations to develop standards-based solutions to address the challenges of data exchange. Its scale and reach - local member organisations in 116 countries, over two million member companies and over 6 billion transaction every day - helps ensure that there is a common language of business used globally [1] across 25 sectors, including consumer packaged goods, transport and logistics, healthcare, construction, and DIY [2] .

GS1's open standards are based on ISO standards. They create a common foundation for business to uniquely identify, accurately capture and automatically share information about products, locations and more [3]. Businesses can also combine different GS1 standards to streamline processes - such as interoperability and traceability systems for supply chains [4]. GS1 provides a common set of standards to share sustainability information widely, both for Business-to-Business (B2B) and Business-to-Customer (B2C) purposes.

The aim of this paper is to investigate how GS1 standards can be used to meet the requirements of the DPP for construction products.

To put this in context, it is useful to describe the timeline of the development of the DPP proposed by the European Union (EU) and the proposal for a Construction Products Regulation (CPR) with the aim of reducing greenhouse gas emissions. This will be done in the context of ISO standards created to improve traceability, data sharing and safety for construction products in the EU using BIM processes. This paper is based on the ESPR Commission proposal, which may be modified as it goes through the legislative process. The final publication in the Official Journal of the EU is expected by March 2024.

The methodology of this paper is problem-solving research based on a desk study, where on one side it examines the requirements of the DPP and ISO BIM standards, and on the other explains how GS1 Standards would fit as a possible solution to enable the digital transformation which is essential to meet these requirements.

Conclusion and recommendations appear at the end of the paper. References and an appendix are also included.

2. Literature review

The construction ecosystem represents almost 10% of EU value added and employs around 25 million people in over 5 million firms. The construction products industry counts 430,000 companies in the EU, with a turnover of €800 billion. These are mainly small and medium-size enterprises. They are a key economic and social asset for local communities in European regions and cities. Buildings are responsible for around 50% of resource extraction and consumption and more than 30% of the EU's total waste generated per year. In addition, buildings are responsible for 40% of EU's energy consumption and 36% of energy-related greenhouse gas emissions [5].

The collision of major crises and economic shocks in recent years has impacted every part of the EU's economy and society. But these crises also have much in common, and force one to question assumptions, to rethink economic models and to work on redesigning energy systems. These dependencies and vulnerabilities can lead to issues with security of supply, financial strain on households and shocks for businesses whose daily operations and long-term survival may be at risk.

Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, on the 11th of December 2019 the EU announced, "A European Green Deal" (EGD) to transform the EU into the first climate-neutral continent by 2050 [6]. To deliver the EGD, there is a need to rethink policies for energy supply across many sectors, including construction [7]. Therefore, the EU has adopted a set of proposals to make the EU's climate, energy, transport, and taxation policies fit for

reducing net greenhouse gas emission by at least 55% by 2030, compared to 1990 levels, and for no net emissions of greenhouse by 2050 [8].

On the 11th of March 2020, the EU published "A New Circular Economy Action Plan" (CEAP) for a cleaner and more competitive Europe [9]; it is one of the main planks of the EGD. The new action plan announces initiatives along the entire life cycle of products. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is preserved, and the resources used are kept circulating in the EU economy as long as possible [10].

As part of the governance of the sectorial actions, the Commission will cooperate closely with stakeholders in key product value chains to identify barriers to the expansion of markets for circular products and ways to address those barriers, these product value chains are:

- Electronics and ICT
- Batteries and vehicles
- Packaging
- Plastics
- Textiles
- Construction and buildings
- Food, water and nutrients [11]

On the 30 March 2022, the European Commission adopted the package of measures proposed in the CEAP. These are:

- Sustainable Product Initiative, including the proposal for the Ecodesign for Sustainable Products Regulation (ESPR)
- EU strategy for sustainable and circular textiles
- Proposal for a revised Construction Products Regulation
- Proposal for empowering consumers in the transition

The following is a brief description for each of these measures:

The ESPR proposal establishes a framework for setting Ecodesign requirements for sustainable products and repealing Directive 2009/125/EU, which had only covered energy-related products [12]. This framework will allow for the setting of a wide range of

requirements, including:

- Product durability, reusability, upgradability, and reparability
- Presence of substances that inhibit circularity
- Energy and resource efficiency
- Recycled content
- Remanufacturing and recycling
- Carbon and environment footprints
- Information requirements, including a Digital Product Passport (DPP) [13].

The idea to bring in a DPP is generally supported by clear majorities across all stakeholder groups on their impact assessments, as are incentives and tools to stimulate demand for sustainable products.

Article 8 of this document "Product Passport" cites: the information requirements referred to in Article7(1) shall provide that products can only be placed on the market or put into service if a product passport is available in accordance with the applicable delegated act adopted pursuant to Article 4 "Empowerments to adopt delegated acts", Article 9 "General requirements for the product passport" and 10 "Technical design and operation of the product passport".

Article 12 "Product passport registry" cites "The commission shall set up and maintain a registry storing information included in the product passports required by delegated act adopted pursuant to Article 4".

Moreover, under point 32 of the proposal, it requires that the product passport is flexible, agile, and market-driven and evolving in line with business models, markets and innovation; it should be based on a decentralised data system, set up and maintained by economic operators.

However, for enforcement and monitoring purposes, it may be necessary that competent national authorities and the Commission have direct access to a record of all data carriers and unique identifiers linked to products placed on the market or put in service [14]. In support of this document Annex III, which refers to Article 8, lists and specifies the information that can be included in the product passport.

The EU strategy for sustainable and circular textiles addresses the production and

consumption of textiles sectors. It implements the commitments of the European Green Deal, the Circular Economy Action Plan and the European Industrial Strategy. Textiles are in in the fabrics of everyone's daily lives. They are used to apparel, household textiles and in the furniture, and also in products such as medical and protective equipment, building and vehicles. In the EU, the consumption of textiles, most of which is imported, now accounts on average for the fourth highest negative impact on the environment and on climate change and third highest for water and land use from global life cycle prospective [15].

The proposal for "laying down harmonised conditions for the marketing of construction products, amending Regulation (EU) 2019/1020 and repealing Regulation (EU) 205/2011" [16], (the CPR). This regulation provides a common technical language to assess the performance of construction products. It ensures that reliable information is available to professionals, public authorities, and consumers, so they can compare the performance of the products from different manufacturers in different countries of the EU [17].

Article 78 of this proposal, "EU construction database or system" cites: "The Commission is empowered to supplement this Regulation by meaning of delegated act according to Article 78, by setting up a Union construction products database or system that builds to the extent possible on the Digital Product Passport established by Regulation (EU)… [Regulation on Ecodesign for sustainable products].

Similar to the ESPR, the enacting terms of the proposal for the CPR are accompanied by several annexes. Annex III, on the procedure for the adoption of a European Assessment Document (EAD) [18] will also play an important role in the implementation of the DPP.

The Commission's proposal will empower consumer to make informed and environmentally friendly choices when buying products. Whether it is a mobile phone or a kitchen appliance, consumer will be better informed about how long the product is made to last and if it can be repaired. The new rules will also better protect consumers against misleading practices related to greenwashing or to early obsolescence of products [19].

Figure 1 shows a timeline of this package of measures proposed in the CEAP, starting from the EGD in 2019.

Fig. 1: Timeline of the development of the DPP and CPR

Two more ordinary legislative procedures strictly related to the construction industry and to be monitored are:

- 30 June 2023, 2020/0353 (COD) "Draft, concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC (first reading) [20].
- 30 Nov. 2022 COM (2022) 677 final, 2022/0396(COD) "on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing 94/62/EC" [21].

Figure 2 below shows the interconnectedness of the various EU strategies and regulations. It illustrates how the ESPR functions as safety net in cases where sectoral legislation does not sufficiently address environmental sustainability goals.
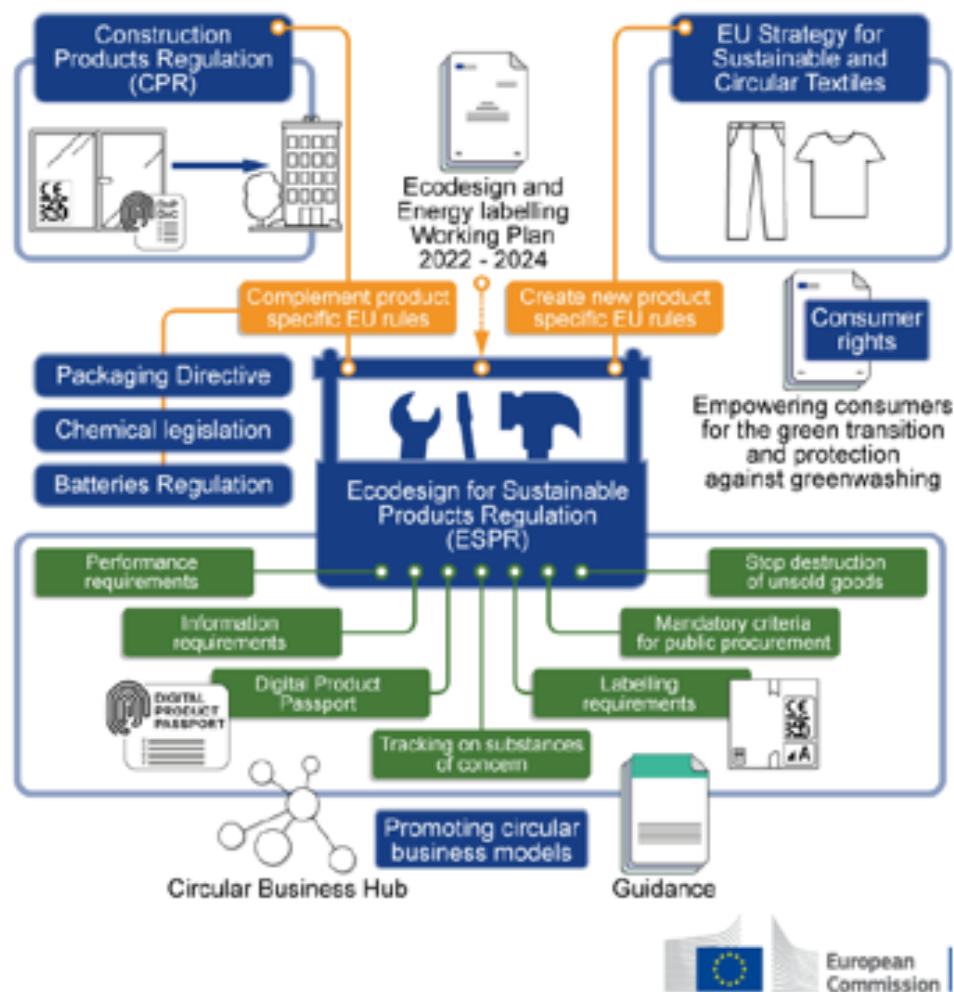

Fig. 2: Circular Economy Spring 2022 Package by the EU

The construction industry is traditionally complex, fragmented, and siloed. It is not unusual for stakeholders in construction to work independently of each other even though they are required to produce a common result. This makes progress towards the Green Deal and digitalisation in the whole industry a significant challenge.

In parallel to the development of the DPP and CPR, which will take effect in 2026 for construction products, a number of ISO and BS standards have been developed with the aim to improve traceability and data sharing of construction products, these are:

ISO 23386:2020 "Building information modelling and other digital processes used in construction – Methodology to describe, author and maintain properties in interconnected data dictionaries". This document establishes the rules for defining properties used in construction and a methodology for authoring and maintaining them, for a confident and seamless digital share among stakeholders following a BIM process.

ISO 23387:2020 "BIM – Data template for construction objects used in the life cycle of built assets – Concept and principles". This document sets out the principles and structure for data templates for construction objects. It is developed to support digital processes using machine-readable formats using a standard data structure to exchange information about any type of construction object e.g., product, system, assembly, space, building etc., used in the inception, brief, design, production, operation, and demolition of facilities [22].

Arising from a recommendation in the Hackitt report, following the Grenfell Tower tragedy in 2017 [23], a new British Standard for Digital Management of Fire Safety Information, has recently been published, (BS 8644-1:2022 [24].

This standard is intended to be read in conjunction with the ISO 19650 series for managing information over the whole cycle of a built asset and to manage fire safety information using BIM processes [25].

BS 8644 builds on ISO 19650 series where appropriate in relation to fire safety information for buildings and assets subject to the requirements of the Building Safety Act 2022. It includes additional requirements to record data over and above Construction Operations Building Information Exchange (COBie), for non-maintainable assets (e.g., walls, structural columns).

This has a similar approach to the proposed ESPR. As a result, by combining ISO 19650 with the ESPR, the scope of the DPP/CPR will enable the right people to get the right information at the right time. This includes clear assignment of tasks, recording of events and managing fire safety throughout the lifecycle of the asset.

There follows in this paper a list of GS1 Standards based on ISO and other standards and applicable in the construction industry.

GS1 Standards and their ISO/IEC basis	
GS1 Standard	ISO/IEC Standard
GTIN (Global Trade Item Number)	ISO/IEC 15459-6 & ISO/IEC 6523
GLN (Global Location Number)	ISO/IEC 6523
SSCC (Serial Shipping Container Code)	ISO/IEC 15459-1 & ISO/IEC 6523
GIAI (Global Individual Asset Identifier)	ISO/IEC 15459-4 & 5 ISO/IEC 6523
GSRN (Global Service Relationship Number)	ISO/IEC 15418
EAN/UPC barcode	ISO/IEC 15420
GS1 Data Matrix	ISO/IEC 16022
GS1 QR Code	ISO/IEC 18004
EPC Tag Data Standard	ISO/IEC 15962

Table 1: GS1 Standards as part of ISO and other standard bodies

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There follows in this paper a list of GS1 Standards based on ISO and other standards and applicable in the construction industry.

The main GS1's identification keys used in construction are:

GTIN or Global Trade Item Number can be used by a company to uniquely identify a construction product. This number can be encoded in a barcode applied to packaging or to the product itself, or in a Radio Frequency Identification (RFID) tag.

GMN or Global Model Number is used to identify a product model or product family.

GLN or Global Location Number can be used to identify legal location, physical location, functional location entity or location.

SSCC or Serial Shipping Container Code can be used to identify logistics units.

GIAI or Global Individual Asset Identifier is used to uniquely identify a specific asset. This could be an Air Handling Unit, Pump, Lift, etc.

GSRN or Global Service Relationship Number can be used by services organisations to identify their relationships with individual service providers (such as Field Service Engineers and equipment Installers) and individual service clients (such as the metering points of an electricity company).

These identifiers are usually encoded in data carriers (barcodes and RFID tags). The main ones used in Construction are:

EAN/UPC barcodes are linear barcodes and are printed on virtually every consumer product in the world. They are the longest-established and most widely used GS1 barcodes.

GS1 Data Matrix is two-dimensional symbol and because of its small size and high information capacity is used in multiple industry sectors including electronics, automotive, aerospace and healthcare – has in-built error connection, to compensate for the lost or missing data, or damage to the barcode, making it very accurate and secure.

GS1 QR Code is a two-dimensional square barcode that carries text-based data. Thanks to the GS1 Digital Link standard, it is now possible to include a GS1 identifier and a website link in a QR code.

Electronic Product Code (EPC) Tag Data Standard specifies the data format of the EPC, and provides encodings for numbering schemes, including the GS1 keys within an EPC.

The three major advantages of GS1 standards are that they are globally unique, interoperable & persistent. Because of this GS1 standards enable the identification, capturing, and sharing of information on products and services in a global circular economy where product and asset life spans are often measured in decades.

Figure 4 and 5 in the appendix, demonstrate how the GS1 standards function for both B2B & B2C exchanges of information in a linear supply chain and throughout an asset's life cycle. The challenge for the industry is to convert a linear supply chain into a circular supply chain.

Figure 3 builds on Closing the Loop – Circular Economy Action Plan (2015). It emphasises the importance of reducing waste to ensure a well-functioning internal market for high quality secondary raw materials [26].

Fig. 3 Circular economy © European Union

3. Methodology

The methodology selected for this paper is the problem-solving approach (action research) based on a desk study. It examines the DPP requirements as stated in the ESPR, CEAP and CPR. It then identifies where GS1 Standards can address them.

4. Problem solving approach

The proposal for the ESPR includes the following relevant sections:

Point 32 requires that the product passport is flexible, agile, and market-driven and evolving in line with business models, markets, and innovation. It should be based on a decentralised data system, set up and maintained by economic operators. However, for enforcement and monitoring purposes, it may be necessary that competent national authorities and the Commission have direct access to a record of all data carriers and unique identifiers linked to products placed on the market or put in service.

Article 9 General requirements for the product passport:

1. A product passport shall meet the following conditions:

    (a) it shall be connected through a data carrier to a unique product identifier.

    (b) the data carrier shall be physically present on the product, its packaging or on documentation accompanying the product, as specified in the applicable delegated act adopted pursuant to Article 4.

    (c) the data carried, and the unique product identifier shall comply with standard ('ISO/IEC') 15459:2015

    (d) all information included in the product passport shall be based on open standards, developed with an inter-operable format and shall be machine-readable, structured, and searchable, in accordance with the essential requirements set out in Article 10.

    (e) the information included in the product passport shall refer to the product model, batch, or item as specified in the delegated act adopted pursuant to Article 4.

The GS1 Global Trade Item Number (GTIN) meets all these requirements. When encoded in a GS1 compliant 2D barcode or Radio-Frequency Identification (RFID) Tag, this unique product identifier can be physically attached to the product or product packaging or on accompanying documentation. It complies with the ISO/IEC 15459:2015 standard and is open, interoperable, and persistent in that it will not normally be changed over its lifetime, which may be several decades. Where changes are necessary (e.g., where the product is recycled) there will be industry-agreed processes and rules in place to minimise and loss of traceability data.

Article 12 Product passport registry: Section 1. The Commission shall set up and maintain a registry storing information included in the product passports required by delegated acts adopted pursuant to Article 4.

This registry shall at least include a list of the data carriers and unique product identifiers referred to in Article 9(1).

Section 4. The economic operator placing the product on the market or putting it into service shall upload, in the registry referred to in paragraph 1, the information referred to in paragraph 2.

Section 5. The Commission, competent national authorities and customs authorities shall have access to the registry referred to in this Article for carrying out their duties pursuant to Union legislation.

GS1 GTINs are already used in many registries such as the GS1 Registry Platform,

the Global Data Synchronous Network, national and regional registries, and in the Product Information Management and Enterprise Resource Management Systems of individual companies. This will make it easier for economic operators to share their data and lead to better data quality. Having this common identifier will make it easier to link data across registries.

From Annex III, Digital Product Passport (referred to in Article 8) of the ESPR:
Section (b) the unique product identifier at the level indicated in the applicable delegated act adopted pursuant to Article 4.

Section (c) the Global Trade Identification Number as provided for in standard ISO/IEC 15459-6 or equivalent of products or their parts.

Section (g) information related to the manufacturer, such as its unique operator identifier and the information referred to in Article 21 (7)

Section (h) unique operator identifiers other than that of the manufacturer.

Section (i) Unique facility identifiers.
Section (k) the name, contact details and unique operator identifier code of the economic operator established in the Union

responsible for carrying out the tasks set out in Article 4 of Regulation (EU) 2019/1020, or Article 15 of Regulation (EU) [.../...] on general product safety, or similar tasks pursuant to other EU legislation applicable to the product.

The GS1 GLN is used to uniquely identify legal entities (such as economic operators, manufacturers and brand owners) and physical locations (including factories, production lines and corporate offices). It is widely used in Retail, DIY and Healthcare in Ireland.

The CPR includes the following relevant article:
Article 78, EU construction database or system
Section 1. The Commission is empowered to supplement this Regulation by meaning of delegated act according to Article 87, by setting up a Union construction products database or system that builds to the extent possible on the Digital Product Passport established by Regulation (EU)... [Regulation on Ecodesign for sustainable products].

The GS1 identifiers for products, economic operators and locations can be used across the product databases for the CPR and DPP thereby providing global uniqueness, interoperability, and persistence.

5. Conclusions

This paper describes the origin of the Digital Product Passport and the Construction Products Regulation and their benefits for reducing greenhouse gas emissions if implemented in multiple industry sectors, including construction.

The problem-solving approach section described how GS1 Standards meets the stated requirements of the DPP and CPR for globally unique, open, interoperable, and persistent product identification that complies with ISO Standards. These are recommendations for future works:

The requirements of the DPP/CPR have yet to be fully defined. In the meantime, manufacturers should ensure that their products are identified using a standard that complies with ISO 15459.

As more details emerge about the DPP and the CPR, the sector needs to work together at national, regional, and international levels to develop Data Dictionaries (ISO/IEC 22386) and Product Data Templates (ISO/IEC 22387) that meet the requirements of the legislation.

Manufacturers in Ireland are already recognising that they need to identify their products in order to meet the requirements of the DPP. Industry stakeholders in the Norwegian public sector [27] and in the Swedish private sector [28] have already mandated the GS1 GTIN for product identification for this purpose.

When the regulations have been operating for some time, further research could be undertaken to investigate any gaps in the standards discussed here or in their application.

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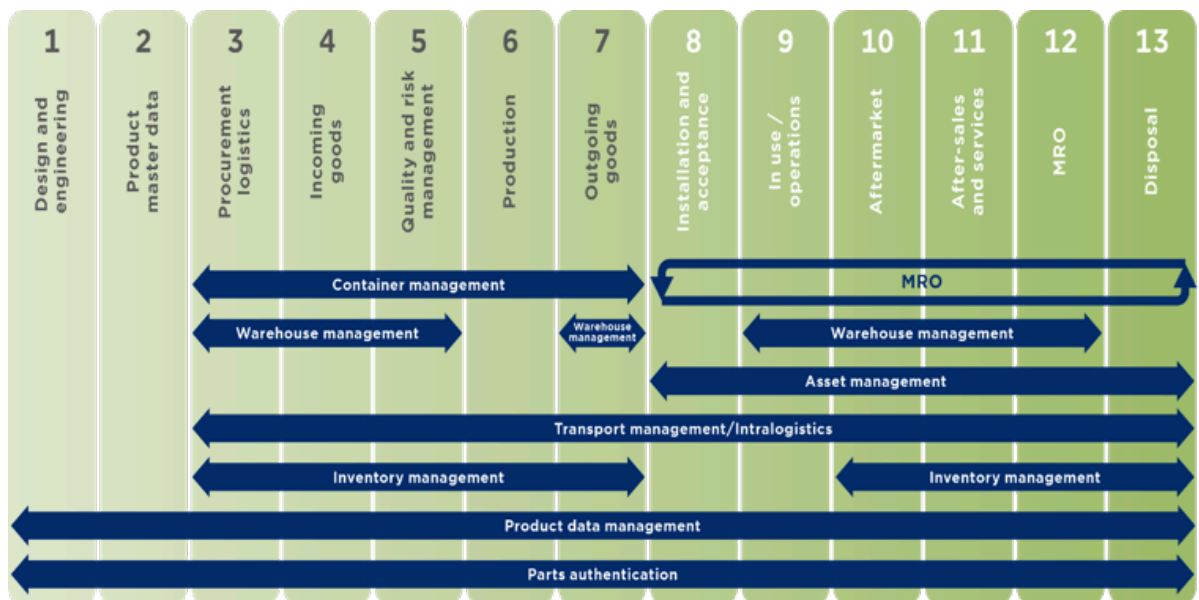
7. Appendix

Fig. 4 – GS1 Identification Keys (Courtesy of GS1)

Fig. 5 – GS1 Technical Industry life cycle (Courtesy of GS1)